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EFFECT OF COTTONSEED MEAL INCLUSION IN DIETS OF *Catla catla* (HAMILTON, 1822)

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ABSTRACT
Five diets designated as CSM0, CSM5, CSM10, CSM15 and CSM20 with 0, 5, 10, 15 and 20% of cottonseed meal inclusion levels respectively were fed to *Catla catla* (Hamilton, 1822) for 3 months and the effect studied. All the formulated diets were isonitrogenous with 30% crude protein. Feed was given at the rate of 5% of the body weight and animals were fed twice a day throughout the 3-month duration. Significant difference was observed in the Growth, Protein Efficiency Ratio and Condition Factor of the fishes. Better growth performance was observed at 5% inclusion of CSM. However, no significant differences ($P > 0.05$) were observed in the growth, survival and condition factor at inclusion levels of 5% and 10% CSM in the diet. Hence, it is recommended that CSM can be included upto10% level in the diets of catla. Further inclusion of CSM results in growth depression.

KEYWORDS: Cottonseed meal, *Catla catla,* Growth, Survival

INTRODUCTION
Indian major carp (IMC), *Catla catla* is the major cultivable freshwater fish raised in India on supplementary dietary combinations of plant and animal feed stuffs (Jhingran, 1991). Animal feed stuffs have high nutritional value and palatability but are expensive and may not always be readily available. There is therefore, an urgent need to develop low cost, nutritionally balanced IMC diets that can support increased production levels. Thus, the replacement of animal protein with plant protein sources which are more consistently available and cheaper to produce have been extensively used in aqua feeds.

Cottonseed meal (CSM) is the third largest oil seed meal product in world production after soybean meal and rapeseed meal (USDA, 2000). It has an immense potential for incorporation in aqua feeds since it has high protein value, palatability and as well as low market price in comparison to other high plant proteins sources and fish meal. The earlier experiments on cottonseed meal were mainly done on cultivable fishes like trouts, salmons, tilapia and channel catfish. Limited studies have been conducted on the use of cottonseed meal-based diets on carps. However, the presence of gossypol, an anti-nutritional factor, is the main constraint that limits the use of CSM in diets of fishes. Thus the present study evaluates the possibility of utilizing CSM in diets for IMC, *Catla catla* using the parameters of growth and survival at different levels of CSM in the diet.

MATERIALS AND METHODS
Experimental setup
Catla catla fingerlings (mean wt. 5.45g) were obtained from fish farmers in Somarajupalli, Nellore District. Before starting the experiment, fishes were acclimated in rectangular tanks to laboratory conditions for a period of 15 days. Ten fishes were stocked in each aquarium and triplicates were maintained for all four treatments and the control. The feeding experiments were carried out for a period of 90 days. The experimental treatments designated as CSM5, CSM10, CSM15 and CSM20 had 5, 10, 15 and 20% levels of cottonseed meal respectively. The control group received the diet with same ingredients but devoid of cottonseed meal which was designated as CSM0. The five experimental diets were formulated to be isonitrogenous (30% crude protein).

Feed Preparation
Feed formulation was done using the Pearson's Square Method. Feed was prepared with locally available feed ingredients such as soybean meal (SBM), de-oiled rice bran (DOB), groundnut cake (GNC), cottonseed meal (CSM) and vitamin & mineral premix. The ingredient composition of the various test diets is presented in Table 1.

Table 1: Proximate composition of the ingredients (% on dry matter basis)

Composition Ingredients	Moisture	Crude Protein	Crude Fibre	Ether Extract	Total Ash
Soybean Meal	9.80	37.30	9.20	4.60	5.60
Groundnut Cake	9.40	38.40	7.30	5.68	7.60
Deoiled Rice Bran	8.20	12.50	22.50	3.90	15.80
Cottonseed Meal	7.69	20.04	16.65	3.53	4.24

Each feed ingredient was ground in a mixer. All the ingredients were included in required proportion and thoroughly mixed. Water was added at the rate of 25ml for every 100g of feed and dough was prepared. The dough was cooked for 15 minutes in an autoclave and then cooled. Vitamin and mineral premix was added. The dough was pressed through a mechanical pelletizer with a sieve of 2 mm diameter, oven dried until the moisture level was reduced to approximately 10% and they were stored properly in airtight bottles and kept in a dark cool place. All the diets were analyzed for proximate composition. The feed formulation and proximate composition of the various test diets is presented in Table 2.

Table.2: The ingredient and proximate composition of the experimental diets (% dry matter)

Ingredients	CSM0	CSM5	CSM10	CSM15	CSM20
Ingredient Composition					
Soybean Meal	35.0	35.0	35.0	35.0	35.0
Ground Nut Cake	35.0	33.5	32.0	30.5	29.3
Deoiled Rice Bran	28.0	24.5	21.0	17.5	13.7
Cottonseed Meal	-	5.0	10.0	15.0	20.0
Vitamin and Mineral mix	2.0	2.0	2.0	2.0	2.0
Total	100	100	100	100	100
Proximate composition (in %)					
Moisture	9.02	8.97	8.93	8.89	8.85
Crude Protein	29.99	30.37	29.97	30.09	30.21
Crude Fibre	12.08	11.78	11.95	11.81	11.67
Ether Extract	4.69	4.67	4.60	4.56	4.58
Total Ash	9.04	8.59	8.13	7.64	7.14

Feeding

Fishes were fed twice a day at the rate of 5% body weight. Daily ration was divided into two parts; $2/3^{rd}$ ration was given between 10-10.30 am and remaining $1/3^{rd}$ was fed between 6.00-6.30pm.

Analysis

Water quality parameters (Temperature, pH, Dissolved oxygen, Total alkalinity and Total hardness) were monitored during the study period according to APHA (2005) method. The proximate compositions of the feed ingredients were analyzed using the standard methods by AOAC (1995). At intervals of 15 days, length-weight data was collected and growth performance (weight gain, feed conversion ratio, protein efficiency ratio, condition factor) and survival were estimated. At the end of the experiment hepatosomatic index and specific growth rate were calculated.

Calculations

The following variables were calculated:

Weight gain (WG %) = (final body weight – initial body weight) / initial body weight x100

Specific growth rate (SGR) = [ln (final weight / initial weight) / days of the experiment] x 100

Feed conversion ratio (FCR) = feed consumed (gram dry weight) / weight gain (g)
Protein efficiency ratio (PER) = weight gain (g) / protein intake (g)
Condition factor (K) = [(gram body weight) / (body length. cm)^3] x 100
Hepatosomatic index (HSI) = (liver weight / whole body weight) x 10
Survival % = [(initial number stocked – number of fish dead) / initial number stocked] x 100

Statistical Analysis
The data obtained on Growth, Survival and Feed Conversion Ratio, Protein Efficiency Ratio and Condition factor was treated statistically by applying two way ANOVA classifications according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION
The mean values of percentage weight gain, Feed Conversion Ratio (FCR), Protein Efficiency ratio (PER), Specific Growth Rate (SGR), Survival, Hepatosomatic Index (HSI) and Condition Factor (K) were presented in Table 3.

Table 3: Growth Parameters and Survival of *Catla catla* fed different diets:

Item	CSM0	CSM5	CSM10	CSM15	CSM20
Initial Wt (g)	5.43±0.16	5.51±0.15	5.58±0.07	5.50±0.10	5.24±0.05
Final Wt (g)	15.96±0.10	16.71±0.11	16.51±0.04	16.12±0.13	15.38±0.11
Weight gain (g)	10.53	11.20	10.93	10.62	10.14
Weight gain (%)	193.92	217.48	195.88	193.10	193.51
FCR	4.13 ±0.14	4.00 ±0.10	4.10 ±0.05	4.13 ±0.03	4.08 ±0.03
PER	0.81±0.03	0.82±0.02	0.81±0.01	0.80±0.01	0.81±0.01
SGR	1.20±0.04	1.23±0.04	1.21±0.02	1.19±0.01	1.21±0.02
Survival (%)	96.7	96.7	93.3	90.0	86.7
HSI	1.27±0.10	1.24±0.08	1.22±0.0.08	1.16±0.02	1.15±0.02
Condition Factor	1.10±0.05	1.11±0.04	1.12±0.02	1.08±0.03	1.05±0.04

The percentage weight gain reached a maximum in the group CSM5 (217.48%) and minimum in the group CSM15 (193.10%). The FCR in the group CSM5 significantly differed from all other test diets with the best result (4.00±0.10) and the poorest FCR was observed in the control group CSM0 (4.13±0.14). Highest PER was observed in the group CSM5 (0.82±0.02) and least in CSM0 (0.81±0.03). SGR was observed to be the best in the group CSM5 (1.23±0.04) and least in the group CSM15 (1.19±0.01). In all the groups, survival was observed more than 85%. HSI was observed highest in the group CSM0 (1.27±0.10) and least in the group CSM20 (1.15±0.02). Condition factor was observed to be the best in the group CSM10 (1.12±0.02) and poorest in CSM20 (1.05±0.04).

The amount of CSM that can be used in diets for fishes depend on species, size of the fish, gossypol level present in CSM, availability of essential amino acids (EAA) like lysine and methionine, minerals like phosphorus (P) and iron (Fe) in the feed. In addition, fortification with essential amino acids (EAA) and/or supplementation with minerals and enzymes may also influence the inclusion level of CSM.

Weight increment was observed to be significant ($P< 0.05$) at 5% CSM in the fishes. Growth depression was observed when CSM level increased above 5% CSM in the fishes. Similar results were observed by Usmani *et al*. (1997). They observed that inclusion of more than 5.41% of CSM in the diet resulted in growth depression in *Labeo rohita* of 5 gram size.

In the present study FCR was observed between 4.00±0.10 (CSM5) to 4.13±0.14 (CSM0). Usmani *et al.* (1997) reported FCR of 1.98 to 2.62 in *Labeo rohita*. The difference observed in the present study may be due to

difference in species, digestibility of the ingredients and higher ash content in the feed. However, similar FCR values (5.13 to 5.58) were observed by Latif *et al.* (2008) when low cost oilseed cakes were used as dietary protein source for *Labeo rohita* fingerlings at different combinations. In the present study better FCR values were observed at CSM5 fed fishes. Further increase in the CSM level resulted in higher FCR values. However, all treatment groups showed better FCR than the control group.

In the present study PER was observed between 0.80 - 0.82 in different treatments. Similar observations were made by Ramachandran and Ray (2007) when rohu was fed with compound diets at 20-40% inclusion of fermented black gram based diets.

In the present study specific growth rate (SGR) of catla was recorded between 1.19-1.23. Fishes fed CSM5 showed better SGR compared with the other groups. Similar trend was observed by Tahir *et al*. (2008). They supplemented different types of oilseed meals (cottonseed meal, maize gluten, rice polish, sunflower seed meal, canola seed meal) in the diets and fed to the fishes. The SGR recorded was between 0.959-1.067 which was similar to the present study.

In the present study, though condition factor increased with increasing levels of CSM up to 10%, further increase in CSM resulted in decrease in condition index of catla. These results are in agreement with studies conducted by Pham *et al.* (2007) on Japanese flounder, *Paralichthys olivaceus*. They explained that the low condition index might be caused by the trend of lower growth rate. In the present study also 15% or 20% of CSM resulted in reduced growth as well as reduced condition index.

In the present study inclusion of CSM beyond 5% resulted in reduced HSI. Similar trend was reported by Nelson (2008) in tilapia, *Oreochromis niloticus*. This can be explained by reduced growth performance at 10, 15 or 20% level of CSM inclusion.

In the present study there was no significant difference ($P > 0.05$) observed in survival rates among CSM0, CSM5 and CSM10 in catla. High survival rates were also reported when CSM was included in diets of different fish species; *Oreochromis* spp (Mbahinzireki *et al*., 2001; Yue and Zhou, 2008), *Ictalurus punctatus* (Luo *et al*., 2006), *Carassius auratus gibelio* (Gui *et al*., 2010), *Oncorhynchus mykiss* (Dadgar *et al*., 2009) and *Paralichthys olivaceus* (Pham *et al*., 2007; Lim and Lee, 2008).

There was no significant difference ($P > 0.05$) observed in the growth, survival and condition factor when the diets were fed at inclusion level of 5% and 10% CSM to the fishes. Hence, it can be recommended that CSM can be included up to 10% level in the diets of catla. Further inclusion of CSM results in growth depression.

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